CITY OF VANCOUVER | GREENEST CITY

Heat reclaim system reduces natural gas consumption 96%, greenhouse gas emissions 76%

In 2014, Vancity engaged SES Consulting, an engineering consulting firm, to replace the aging boiler plant in their head office. The building houses a large data centre on the third floor with year-round cooling requirements.

One of Vancity's operating goals is to provide environmental sustainability leadership in the financial sector. This includes a commitment to reduce their operations' negative environmental impact. Consequently, when the boilers came up for renewal, the company was looking to implement feasible and profitable energy efficiency improvements.

Address	183 Terminal Ave, Vancouver
Ownership	Vancity Credit Union
Management	Self-Managed
Type of building	Office
Year of construction	1995
Number of floors	13
Floor area	115,200 sq ft

CASE STUDY - VANCOUVER

VANCITY HEAD OFFICE

THE BUILDING Located at the Main Street Science World SkyTrain station in Vancouver, the Vancity's head office is a 13-storey, 115,000 sq ft tower that was purpose-built for the credit union and houses a retail branch on the ground floor.

Pre-Retrofit Energy Type	Annual Energy Use *GJ*	BEPI *kWhe/m2*	Annual Expenditure *$*	GHG *tCO_2e*
Gas	5,200	130	50,000	260
Electricity	11,000	280	140,000	70
Total	**16,200**	**410**	**190,000**	**330**

EXISTING MECHANICAL EQUIPMENT *pre-retrofit*

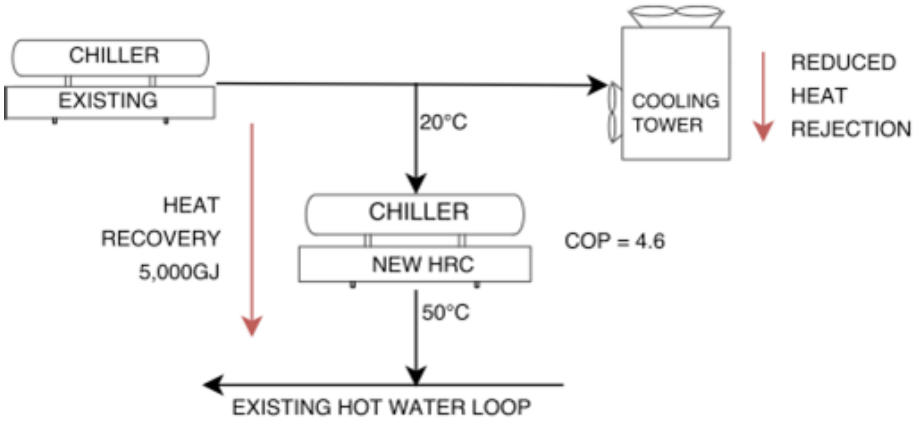
200 ton Multistack Chiller
2 Baltimore Aircoil Cooling Towers
2 Super Hot Boilers
12 Air Handling Units (AHUs)
168 Variable Air Volume (VAV) heat distribution boxes
33 Heat Pumps
2 Libert Computer Room Air Conditioning Units (CRACs)

THE SOLUTION

As part of the BC Hydro Continuous Optimization program, SES Consulting proposed to Vancity a new heat recovery chiller (HRC) to capture waste heat from the data centre and use it in the building for space heating. The ability to capture waste heat that was being rejected out of the cooling towers was appealing to Vancity since it meant not only a major reduction in natural gas consumption but also reduced water usage.

SYSTEM DESIGN At the Vancity office tower, the basic system design is simple: heat from the condenser water serving the data centre is transferred to the building's existing hot water heating loop at a temperature of 60°C (140°F). In warmer weather, when the heat is not needed, it is rejected out the cooling towers. The reduced cooling tower and pump usage have partially offset the energy required to operate the chiller. The data centre generates 300,000 Btu/h 24/7, year round. Overall, the retrofit project also included two new, medium-efficiency Allied Engineering Super Hot boilers, two new heat exchangers, various valves, piping and controls work and programming. The gas boilers provide top-up heating, in series with the HRC, when outdoor air temperatures are below 5°C.

Because the gas boilers are only for top-up heating on the coldest days of the year, and the hot water loop temperature has been lowered to 50-60°C, a medium-efficiency boiler is a cost-effective solution as compared to more efficient condensing boilers.



Simple schematic of the system design

TECHNICAL DETAILS

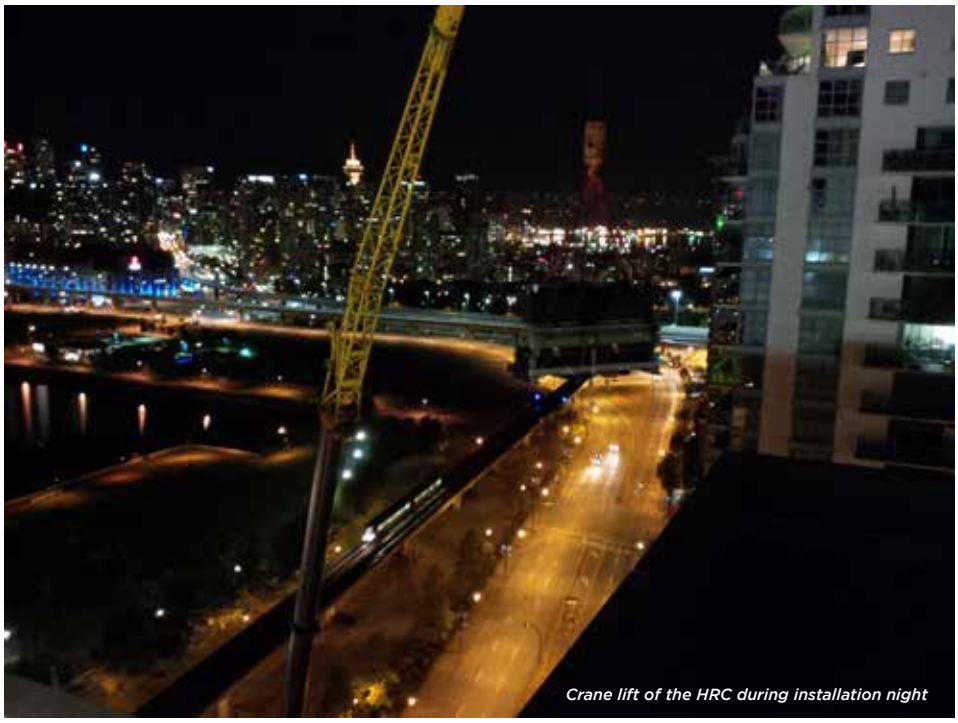
Technology	Heat Recovery Chiller (HRC)
Make & Model	Trane, model RTWD Water-cooled Series R Helical Rotary Chiller
Service provided	Med temp. hydronic space heating
Installation Date	January 2015
Source Temperature	10°C (50°F)
Load Temperature	50°C - 60°C (120°F - 140°F)

Ranging in size from 80 to 250 tons, the rotary chiller operates over a wide range of conditions, temperatures, and under varying loads. It is ideal for both industrial and commercial use.

PROJECT PROCESS The design phase of the retrofit project started in June 2014. Prior to that, the building operators and SES Consulting studied the building's operations closely for one year. This initial retro commissioning process, during which SES Consulting adjusted heating water temperatures and set points, was crucial to determine whether the system temperature could be viably lowered from 80°C to 60°C (176°F to 140°F).

The collaboration between several stakeholders during the consultation, design, and implementation phase of the project was essential: SES Consulting provided the schematic of the design and worked closely with Trane, the manufacturer of the equipment, who was responsible for the HRC's mechanical details and installation. Johnson Controls worked together with SES Consulting to make sure the logic of the building automation system (BAS) would be functioning well.

FortisBC was also involved from the beginning. The utility carried out an additional feasibility study with a third-party reviewer who independently performed the major technical and economic analyses. This verification added a layer of certainty to the project.



Crane lift of the HRC during installation night

HRC in Vancity's mechanical room

PROJECT IMPLEMENTATION & INSTALLATION CONSIDERATIONS The Trane RTWD chiller fits into most existing mechanical rooms without requiring additional floor space or wall tear-outs. Most units can pass through a standard door opening. The single-and dual-point power electrical connection options generally allow using existing electrical wiring.

At the Vancity office, the HRC was installed in January 2015. Due to the building's location on Main Street adjacent to the Skytrain station, the installation had to occur during the night, when the road could be closed off and trains were not running. The equipment was hoisted 13 stories onto the roof and manoeuvred through a 32-inch doorway into the mechanical room.

The HRC integrated simply into the building, connecting to water, electrical and control lines with minimal changes to the existing infrastructure. For the operations team the impact was mostly in the period after the installation as staff worked on fine-tuning the operations and temperature limits.

ANNUAL SAVINGS

96% GAS

20% WATER

76% GREENHOUSE GASES

ECONOMIC ANALYSIS The HRC's capital cost was about $250,000 and installation costs amounted to $63,000. A benefit to the project was FortisBC's incentive of $91,000 which reduced the total installation costs to $222,000. An important condition to secure the utility's incentive was identifying ways of reducing the additional electrical load. This was achieved by the reduced cooling tower and pump usage.

The project reduced Vancity's annual natural gas consumption by 96% (5,000 GJ). Electricity use increased slightly by 2% (70,000 kWh). Combined, this leads to annual energy cost savings of $50,000, resulting in a simple payback on investment of 4.4 years, including the incentive. Important drivers of the project were also the 76% reduction in annual GHG emissions and 20% lower water consumption.

COSTS

Equipment Costs	$250,000
Installation Costs	$63,000
- Fortis BC Incentive	($91,000)
Total Installation Costs	**$222,000**

ANNUAL SAVINGS

Gas *GJ*	5,000
Electricity *kWh*	(70,000)
GHG tCO_2e	250
$	**$50,000**
Simple Payback *years*	
without incentive	6.3
with incentive	4.4
Measure Life *years*	20

"THIS WAS ONE OF THE SMOOTHEST RUNNING PROJECTS WE HAVE HAD IN THE BUILDING'S LIFETIME." Drew Scoular, Vancity

USER EXPERIENCE & RECOMMENDATIONS "The partnership between all of the different stakeholders was crucial; it really felt like a collaborative process where we all used our strengths together. Usually, the project paybacks on paper don't materialize as quickly as planned or are over promised. In our case, we are very happy with the impact this retrofit is having on our GHG emissions and on the bottom line.

"I would recommend the technology if it makes economic sense for the building. There is a learning curve and the more systems are associated the more complicated it can get. But at the end of the day, nothing really changed for the operators of the building; the sequences are different but the building heating and cooling is still the same. The tenants haven't noticed any difference."

Drew Scoular, *Maintenance Supervisor, Facility and Environmental Management, Vancity*

"Most building systems are over designed. The original design load stated that it needed 80°C water but it actually doesn't need to be this high. The retro commissioning was essential to find out by how much we could lower the temperature, which then opened up several retrofit possibilities. Temperatures are really critical to make sure the equipment will run as designed. Otherwise the efficiency savings calculated won't be realized and the back-up boilers would come on a lot more."

Chris Goodchild*, Principal, SES Consulting*

APPLICABILITY Building systems are designed for peak load, but the vast majority of a building's run hours are in milder conditions. This is ideal for medium grade heating systems such as heat recovery chillers.

For commercial buildings, this type of heat recovery solution could be widely adopted. The business case is best in facilities that have year-round cooling needs, such as large office buildings, shopping malls, and ice arenas. Many commercial office and recreational facilities fit in this category.

Medium-grade heat from hot water can be used for many purposes in the building or for process applications. In particular, hot water can be used for heating the building, for service water or as part of a manufacturing or industrial process. For space heating applications, a hydronic heating system is required.

The Trane RTWD chiller fits into most existing mechanical rooms without requiring additional floor space or wall tear-outs. Most units can pass through a standard door opening. The single-and dual-point power electrical connection options generally allow using existing electrical wiring.

LIMITATIONS A comprehensive energy audit is required, which investigates the current state of the entire mechanical system. While a new heat recovery equipment might appear to be a relatively straight forward plug-in solution on the surface, without careful engineering of the heat distribution systems and controls, it is unlikely to be successful.

Depending on the mechanical system configuration, piping and control changes might be required for heat recovery equipment installation. This would add to the installation costs.

In commercial buildings with no process load from a data centre or another simultaneous cooling and heating load, the business case will not be as favourable.

FOR MORE INFORMATION

SES Consulting
info@sesconsulting.com

Trane
Doug.Robertson@Trane.Com

City of Vancouver
green.buildings@vancouver.ca

FortisBC
commercialrebates@fortisbc.com

DESIGN CONSIDERATIONS

For heat recovery systems a very efficient compressor is not required. In fact, a really efficient chiller compressor will generate less waste heat, meaning the system would need to rely more heavily on the top-up natural gas boiler, reducing energy savings.

Most new buildings with Variable Air Volume (VAV) heat distribution systems have an 80°C design temperature, which is much higher than necessary to provide adequate heating. Through optimization of air flow and pump speeds, VAV systems can be retro-commissioned to effectively heat a building with much lower temperatures, as was the case in the Vancity Head Office. By lowering the system temperature to 50-60°C, lowering the zone control set points and optimizing the temperature difference between return and supply hot water, the existing VAV system could be matched with the ideal operating conditions of the heat recovery chiller.

Conducting air-sealing to reduce leakage, prior to the mechanical system retrofit, can result in even greater energy savings, and reduce the system design temperatures.

THE VANCITY BUILDING IS 13 STOREYS TALL. THE DATA CENTER OCCUPIES LESS THAN HALF OF THE THIRD FLOOR. YET, THAT IS ENOUGH HEAT TO WARM THE ENTIRE BUILDING AS LONG AS IT IS MORE THAN 5°C OUTSIDE.